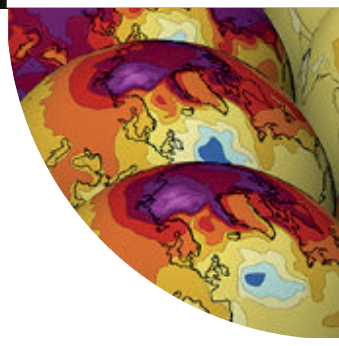
Universität Hamburg
DER FORSCHUNG | DER LEHRE | DER BILDUNG

CLUSTER OF EXCELLENCE
CLIMATE, CLIMATIC CHANGE, AND SOCIETY (CLICCS)

NO TALL TALES, CHATBOT!

HOW ARTIFICIAL INTELLIGENCE CAN MAKE CLIMATE RESEARCH MORE EFFICIENT AND PRECISE

02
JULY 2025



CLICCS QUARTERLY

NEWS FROM CLIMATE RESEARCH

NO TALL TALES, CHATBOT!

Artificial Intelligence is currently revolutionizing virtually every aspect of our lives. At the German Climate Computing Center, Dr. Christopher Kadow is exploring how AI can be applied in climate research. In the following interview, he tells us how to get bots to stop telling tall tales.

What can AI contribute in climate research?

Christopher Kadow: To understand and simulate the climate and the changes to come, we rely on systematic time series – for a huge range of parameters, like temperature and precipitation. But these records don't always go back that many years; in many places, they don't exist at all. That's where AI can help.

So, you can use AI to find missing climate data from the past. How does it work?

Kadow: We have a massive database at the German Climate Computing Center. Over the past 30 years, our supercomputers have addressed a range of questions using diverse climate models. These models in turn use physical formulas to describe climatic processes as precisely as possible and generate datapoints for the entire world. This offers us a veritable treasure trove of data, which we've used to systematically train the AI. Today, when we feed a time series with gaps into the program, we can ask the AI to fill them. And it works extremely well – which we know after having vetted the results with actual observational data from the past.

Will you soon be able to answer questions about the future, too?

Kadow: In test runs, our colleagues at the University are currently pursuing their own research questions on e.g. water levels in the North Sea and Baltic, or on climate predictions. The feedback from the community is extremely valuable for us. For instance, we're now combining these AI-based prediction systems with chatbots like ChatGPT. This combination could allow people to speak with the program and receive direct answers on future-related questions. It would greatly reduce the complexity of communication and open new avenues of research.

How do you handle the dreaded "hallucinations," where chatbots simply make things up?

Kadow: We tell the chatbot to please only use the data we provide – and not to think anything else up. That's an aspect we're fine-tuning at the moment. Though we use the chatbot, we've also added a special interface that can directly translate climate research-related questions into code. The machine executes the programming code – and retrieves the relevant data it needs from our extensive archive.

So, it only uses internal data to find answers. Does that ensure trustworthy results?

Kadow: The results are even reproducible – and not slightly different from time to time, like they are with a chatbot alone. We're now teaching the chatbot how to do scientific programming. We tell it: instead of guessing, use this code. When we do this five times back to back, we get the same result every time – even if the code looks different for each. The bot comes up with the code, but if it's not executed correctly, the computer won't cooperate and reports an error.

What will research look like ten years from now?

Kadow: We'll see bots doing research on their own. They'll be a standard part of research teams, join meetings, make suggestions, and creatively advance research topics.

CLIMATE RISKS: CONCRETE IS BETTER THAN ABSTRACT

Climate extremes are becoming more frequent and intense and often produce extremely high losses – which vary from place to place. Lives could be at risk, as could streets, bridges, the food supply or electricity. Yet to date, countries around the world have neither sufficiently reduced their CO_2 emissions nor adequately prepared for the impacts of climate change. A team led by Prof. Jana Sillmann suggests assessing climate impacts on a place-by-place basis. The approach would make risks something more "hands-on" for decision-makers, helping them plan and implement targeted measures.

General warnings are often abstract – and taking suitable precautions gets put on the back burner. But advances in climate research are making it possible to make many aspects more local and concrete. For example, the effects of heatwaves in small towns: the number of projected heat-related deaths, how many hectares of farmland would suffer crop losses, and how much the water shortage would cost the town. Scenarios like this can make the effects of a climate extreme on decision-makers' own home more tangible, increasing their readiness to invest and plan ahead.

Extreme heat in the city: „water islands" can bring relief.

"We can mitigate many risks by promoting adaptation and prevention. The investment gap is huge," says Sillmann, a climate researcher. After all, it's not just the intensity of extreme weather that determines its impacts; local preconditions for avoiding catastrophes are also a vital aspect.
uhh.de/cliccs-climate-science-and-decision-making

HARVESTS UNDER PRESSURE

Around the world, harvests are at risk: As global warming worsens, there is a growing risk of several breadbaskets – key agricultural regions – being struck by heatwaves simultaneously. A team led by Dr. Leonard Borchert has investigated how frequent and intense these extreme events will likely be in the future. "If the global mean temperature rises by 1.5 degrees, by 2100 at least three central cultivation areas for maize will likely suffer extreme heat every other year. If it rises by two degrees or more, this could happen every year," says Borchert.
The Global South will be hardest-hit: In northern Namibia, maize, beans and millet farming are already jeopardized. By the end of the century, the situation will most likely be worse – with serious consequences, as the people living there are chiefly subsistence farmers and have little or no reserves or other sources of income.
Simultaneous extreme events in multiple regions not only threaten the supply of vital foods at the local level; they also affect global markets and supply chains. Accordingly, the experts call for taking immediate, effective climate action. At the same time, regions must implement targeted adaptation measures – like switching to more heat-resistant crop species and better irrigation systems to mitigate the potentially devastating impacts.
uhh.de/cliccs-outlook2024 (Chapter 4.5, p. 87-92)

A BLUE AND GREEN TOMORROW

How can Hamburg best deal with heavy rains, flooding, storm surges, groundwater-level changes and water shortages in the future? A team led by climate researcher Franziska S. Hanf has developed an innovative approach that blends art and science – while also exploring new avenues of interdisciplinary collaboration. Over a several-year-long process, this produced three plausible future scenarios, corresponding to three different adaptation strategies: purely reactive measures (coping), gradual changes (incremental adaptation) and, as can be seen in the image, fundamental changes (transformative adaptation). Visualized as „narrative images“, they make abstract concepts more tangible. The images promote discussions and combine pluralistic perspectives from the natural, engineering and social sciences.

uhh.de/cliccs-future-narratives

Water aware city
Hamburg 2050

In this scenario, we see a green and blue urban landscape reflecting the concept of "living with water" and the sponge city principles through unsealed drainage areas, floating houses, rooftop gardens, city-wide implementation of "circular economy" strategies, and active citizen involvement through co-creation opportunities. Images like this help society to engage with a more sustainable and viable vision of the future.

NEWS IN BRIEF

A CLEVER APPROACH TO LANDUSE

How can organic farming and nature conservation be reconciled in the EU? As Luisa Gensch shows: intelligent planning can help avoid conflicting goals. Although organic farming could increase demand for land, if systematically implemented, very little farmland would be needed to reach the goal: ten percent land protected. uhh.de/cliccs-organic-farming

EVERY YEAR COUNTS

Even if we quit emitting greenhouse gases today, we'd still see extreme heat in Europe a thousand years from now, as Eduardo Alastrué de Asenjo's simulations show. But every year sooner we reach our climate targets helps ensure the extremes in the coming centuries aren't even worse. uhh.de/cliccs-eu-heat-en

CLIMATE REFLECTS SOCIETY

How did society become part of climate research and how does a standpoint informed by the natural sciences affect notions of society? Sociologist Youssef Ibrahim investigated the development from the mid-19th century to the creation of the IPCC – which won him the Wladimir Köppen Award. uhh.de/cliccs-koeppen-24-en

PUBLISHED BY

Climate, Climatic Change, and Society (CLICCS)
Cluster of Excellence at University of Hamburg

Center for Earth System Research and Sustainability (CEN)
CEN Office, Bundesstraße 53, 20146 Hamburg

Editorial staff: Stephanie Janssen, Thomas Merten, Franziska Neigenfind
cliccs@uni-hamburg.de
www.cliccs.uni-hamburg.de
Follow us on LinkedIn | Bluesky | Mastodon

Image credits
Title: Stergo/Pixabay; p.2: Franziska Neigenfind; p.3 above: pahis/Adobe Stock; p.3 below: Kerstin Jantke; p.4: Vernessa Himmler